MAGNESIUM COMPOUNDS

By Deborah A. Kramer

Domestic survey data and tables were prepared by Jesse J. Inestroza, statistical assistant, and the world production table was prepared by Glenn J. Wallace, international data coordinator.

Production of all magnesium compounds in the United States fell in 2002 compared with 2001, with the largest decrease, 42%, in production of dead-burned magnesia. Caustic-calcined magnesia production was 7% less than that in 2001. A stagnant economy and turmoil in the iron and steel industry were the main reasons for the production declines. Imports continued to supply a significant portion of U.S. magnesia demand, and this portion has become larger in recent years. Although U.S. refractory magnesia production dropped sharply, apparent consumption fell by only 13%. Even though production for caustic-calcined magnesia declined, U.S. apparent consumption increased by 5%. Imports of magnesia helped fill the U.S. production shortfall.

About 55% of U.S. magnesium compounds production came from seawater and well and lake brines. The remainder was recovered from magnesite, dolomite, olivine, and brucite. About 61% of the total consumption of magnesium compounds was for refractory applications. The remaining 39% was used in agricultural, chemical, environmental, and other applications. China remained the dominant supplier of imports for caustic-calcined and refractory magnesias with 60% and 73%, respectively, of the totals.

Production

Production of all magnesium compounds declined in 2002, with the sharpest decrease in refractory magnesia, which fell by 42% (table 3). The decline in refractory magnesia production could be attributed mainly to the stagnant economic conditions in the United States that persisted from 2001 and financial problems in the steel industry. By early 2002, about 29 U.S. steel companies had filed for bankruptcy, and 13 integrated and nonintegrated steelmakers closed. Two of the companies, Bethlehem Steel Corp. and LTV Steel Corp., represented about one-half of the steelmaking capacity and jobs in the industry. According to the American Iron and Steel Institute (undated§[1]), raw steel production in the United States in 2002 was 2.4% higher than that in 2001. Although this should have led to increased production of refractory magnesia because of a rise in demand by the steel industry, apparent consumption of dead-burned magnesia fell by 13%; an increase in net imports helped to meet U.S. demand. Although caustic-calcined magnesia production also was lower than that in 2001 (by 7%), apparent consumption increased by about 5%; again, an increase in net imports helped meet demand.

Data for magnesium compounds were collected by the U.S. Geological Survey from one voluntary survey of U.S. operations. Of the 18 operations canvassed, 61% responded, representing 63% of the magnesium compounds shipped and used (table 3). Data for the seven nonrespondents were estimated on the basis of prior-year consumption levels and other factors.

Two companies in the United States produced olivine—Unimin Corp. and Olivine Corp. Unimin operated two mines, one in North Carolina and one in Washington, and processing plants in Indiana, North Carolina, and Washington. Olivine operated one mine and one processing plant in Washington.

Fused magnesia was produced by two companies in the United States—Newminco Inc. with a plant in Midway, TN, and UCM Group plc of the United Kingdom, which operated a plant in Cherokee, AL, through its Muscle Shoals Minerals Inc. subsidiary.

The largest magnesite production facilities in the world are in China, North Korea, and Russia. Together, these three countries account for two-thirds of the world magnesite production capacity. Japan and the United States account for more than one-half of the world's magnesium compounds production capacity from seawater or brines. Fused magnesia is produced in Australia, Brazil, Canada, China, Israel, Japan, the Republic of Korea, Mexico, Russia, the United Kingdom, and the United States. World production capacity is estimated to be about 650,000 metric tons per year (t/yr), including about 500,000 t/yr of capacity in China (Pearson, 2000).

Norway is the world's principal producer and supplier of olivine. Other producers include Australia, Italy, Japan, Mexico, Pakistan, Spain, and the United States. Rudi (2001) estimated that total world production of olivine averaged about 4 million metric tons per year (Mt/yr), with about 3.3 Mt/yr consumed in Europe.

In early 2002, Germany's RHI AG announced that it wanted to sell all the companies included under its subsidiary RHI Refractories Holding Co. because of increasing asbestos litigation. In February, RHI Refractories announced that three of its businesses, Global Industrial Technologies Inc., Harbison-Walker Refractories Co., and A.P. Green Refractories Co., filed for reorganization under Chapter 11 of the U.S. Bankruptcy Code. North American Refractories Co., the other member of RHI Refractories, had filed for Chapter 11 bankruptcy at the beginning of January (RHI Refractories Holding Co., 2002§). RHI Refractories changed its name to ANH Refractories Co. in August to establish an identity separate from that of RHI AG. At yearend, all subsidiaries continued to operate under Chapter 11.

At the beginning of 2003, Dow Chemical Co. announced that it would idle its Ludington, MI, brine production facility and would purchase the raw material from Martin Marietta Magnesia Specialties LLC. Dow was installing a 43-kilometer pipeline to feed the

[1]References that include a section mark (§) are found in the Internet References Cited section.

brine from Martin Marietta's Manistee, MI, plant to its plant. Dow has recovered calcium chloride and magnesium hydroxide from the brine pumped in Ludington for the past 60 years (Ludington Daily News, 2003a§). This change, however, has a significant impact on ANH Refractories' dead-burned magnesia plant that relies on Dow to supply the plant's magnesium chloride brine feed material. ANH Refractories would have to close the plant after Dow stops supplying brine unless another supplier is found. ANH Refractories employs 70 workers at the Ludington facility (Ludington Daily News, 2003b§).

Several other changes at U.S. magnesia producers were implemented in 2002. Martin Marietta closed its Pittsburgh, PA, magnesium hydroxide slurry plant to consolidate production at Manistee. Premier Chemicals LLC completed a $250,000 investment to retrofit an idled multiple hearth furnace to increase its magnesia production capacity in Florida by 25,000 t/yr. A plant upgrade, which was completed in 2001, allowed Rohm & Haas Co. to increase its production capacity for specialty grades of magnesium hydroxide to 25,000 t/yr in 2002 (Harris, 2002).

UCM Group announced that it would consolidate its fused magnesia operations in the United States. The company operated fused magnesia plants in Greeneville, TN, and Cherokee, AL, but neither was operating at full capacity. The company intended to move magnesia production from Greeneville to Cherokee and use the excess capacity at Greeneville to produce fused zirconia. UCM's total fused magnesia capacity in the United States and the United Kingdom was about 34,000 t/yr but dropped to 28,000 t/yr after the transfer of capacity from Greeneville (Industrial Minerals, 2002c).

Consumption

In 2002, chemical intermediates was the largest end use for caustic-calcined magnesia with 36% of the total. Environmental applications (water treatment and stack gas scrubbing, in descending order) was the second largest end use, with 34% of the total. The following categories, with the individual components in descending order of consumption in parentheses, were the other end-use sectors for caustic-calcined magnesia: agriculture (animal feed and fertilizers), 22%; construction (primarily oxychloride and oxysulfate cements), 5%; manufacturing (rubber, fuel additives, and electrical), 2%; pharmaceuticals and nutrition (sugar and medicine and pharmaceuticals), less than 1%; and unspecified uses, less than 1%.

Magnesium carbonate was used principally as a chemical intermediate, in medicines and pharmaceuticals, in rubber processing, and in cosmetics (uses are given in descending order of quantity). Magnesium hydroxide was used mainly for water treatment and in the chemical industries. Smaller applications for magnesium hydroxide were in medicine and pharmaceuticals, in the construction industry, and in rubber processing. Magnesium sulfate was used mostly for animal feed, pulp and paper, chemical, and pharmaceutical applications. Magnesium chloride was used mainly for ice control and in medicines and pharmaceuticals. Magnesium chloride brines were used principally for road dust and ice control and as a chemical intermediate.

Foundry uses remained the largest application for olivine in the United States, accounting for 78% of consumption of domestically produced material. Slag conditioning accounted for 11% of U.S. consumption; sandblasting and other abrasive uses, 7%; and refractory applications, 4%.

Prices

Most yearend 2002 prices for magnesium compounds quoted in Chemical Market Reporter and Industrial Minerals remained the same as those for 2001 (table 4). Prices for magnesium sulfate (epsom salts), anhydrous magnesium chloride, and foundry-grade olivine increased slightly.

Foreign Trade

In 2002, dead-burned magnesia exports from the United States increased by about 15% (table 5). Canada (75%) and Austria (8%) were the principal destinations. Caustic-calcined magnesia exports were 48% greater than those in 2001. France (52%), the Netherlands (15%), and Italy (14%) were the main destinations.

Imports of caustic-calcined and dead-burned magnesias rose in 2002. U.S. imports of dead-burned magnesia in 2002 were about 9% higher than those in 2001 (table 7). China (73%) and Australia (14%) continued to be the principal source countries. Imports of caustic-calcined magnesia were 14% higher than those in 2001. China (60%) and Canada (33%) were the primary sources.

Trade data for olivine are not available separately from the U.S. Census Bureau. The Journal of Commerce Port Import/Export Reporting Service (PIERS), however, provides data on material that travels by ship. U.S. exports of olivine in 2002 were 850 t, with 84% of the material shipped to Argentina. U.S. olivine imports totaled 97,800 t, a 77% increase from those in 2001. Norway was the source of almost all (99.9%) U.S. olivine imports.

World Review

Australia.—WestMag Ltd. delayed development of its Pilbara magnesia project because the Australian market for magnesia has not developed as rapidly as expected. WestMag had planned on marketing much of its product to Australia's lateritic nickel industry, but the expansion of existing lateritic nickel plants and the development of new deposits have been slower than originally projected. Because of market delays, WestMag has decided that instead of completing the scoping study, which had originally been scheduled to be finished by mid-2002, it would conserve the funds raised through a stock offering. WestMag was evaluating investments in other

projects that would increase short-term shareholder value while waiting for the magnesia market to develop (Industrial Minerals, 2002d).

Australian Magnesium Corp. Ltd.'s 2001-2 annual report included an A$5.6 million writedown provision in the Flamemag joint-venture investment, which was expected to produce magnesium hydroxide for flame- retardant applications, because of the company's decision to focus all of its resources on the magnesium metal and magnesia businesses. By the end of December, QMC (Flamemag) Pty. Ltd. transferred all its shares in Flamemag International GIE to Compagnie Internationale de Developpement Minier, and Flamemag International had transferred all the Flamemag patents and patent applications to QMC (Flamemag). As a result, the Flamemag Australia joint venture was terminated (Australian Magnesium Corp. Ltd., 2002§, 2003§).

Canada.—The Government of Quebec announced that it would invest in a bankable feasibility study for a mine at Globex Mining Enterprises Inc.'s Timmins magnesite-talc deposit. A scoping study, completed in 2001, indicated that a mine, mill, and smelter complex producing 90,000 t/yr of magnesium metal would be an appropriate scale for the project. Globex Mining reported that, based on previous drilling results, the property contains a large body (more than 100 million metric tons) of magnesite, talc, and quartz. The ore body is made up of about 54% magnesite, 27% talc, and 16% quartz, with 3% accessory iron oxides. Globex planned to begin the Can $9 million feasibility study after financing was complete (North American Minerals News, 2002).

China.—UCM formed a manufacturing and distribution arrangement with Yingkou Tianhu Magnesia Industries Co. Ltd. (YTMI), a fused magnesia producer in Liaoning Province. YTMI will produce electrical-grade fused magnesia to UCM's specifications and sell the entire output to UCM. Quantities produced under the agreement were confidential. This arrangement would increase UCM's customer base in China. In 2002, UCM operated fused magnesia plants in the United States and the United Kingdom with a total production capacity of 28,000 t/yr, and UCM is estimated to have supplied about 60% to 65% of the world market for electrical-grade fused magnesia (Industrial Minerals, 2002c).

South Africa.—Optimin SA, a South African industrial minerals firm, and Syferfontein Group jointly purchased the assets of Venmag (Pty.) Ltd. in early 2002. Venmag's assets consist of a magnesite mine and processing plant in Northern Province that has the capability to produce 9,000 t/yr of caustic-calcined magnesite and 50,000 t/yr of crude magnesite. The company's new name is Syferfontein Magnesite. Optimin, which also produces high-grade magnesia from a plant in Zimbabwe, began a feasibility study for production of dead-burned magnesia, magnesium chloride, and magnesium sulfate to supplement imported products. Imports of caustic-calcined magnesia represent about 20% of the market, which is primarily agriculture, water treatment, and cement applications. No dead-burned magnesia is produced in South Africa; the refractories manufacturers import the material that they require (Industrial Minerals, 2002b).

United Kingdom.—After filing for bankruptcy in January, Britmag Ltd. sold its nonrefractory assets in a management buyout to CJC Chemicals Ltd. CJC Chemicals was formed in March by former directors of Britmag. The new company will focus on its magnesia powder and magnesia solution products, which had been profitable previously. The company planned to introduce new products and reintroduced a 99%-magnesia product that had not been successfully produced within the past year. The magnesia slurry that had been used for the 99% product had been used instead as feed for low-value refractory products. Concentration on these low-valued products was cited as the principal reason for Britmag's bankruptcy declaration (Industrial Minerals 2002a).

Outlook

Because refractory applications are the largest use of magnesia, the health of the industries that use magnesia-base refractories is the most important determinant in the U.S. consumption of magnesia. The iron and steel industry is the principal consumer of magnesia refractories; magnesia refractory consumption generally follows iron and steel production (figure 1). In the early part of 2003, the American Iron and Steel Institute reported that U.S. steel production was higher when compared with 2002 production and that imports of steel mill products had decreased. If this trend continues, consumption of dead-burned magnesia is projected to increase in 2003.

The probable closure of ANH Refractories' plant in Michigan would leave Premier Chemicals and Martin Marietta as the only producers of dead-burned magnesia in the United States. This would provide additional opportunities for imports of magnesia to fulfill the U.S. demand. Since 1993, imports have provided more than one-half the U.S. consumption of dead-burned magnesia; this has increased to more than three-quarters in recent years (figure 2). China has become the largest import source, providing, on average, about 70% of the total dead-burned magnesia imports. With a projected increase in consumption and a decline in production, China is expected to continue to supply an even greater share of U.S. demand for dead-burned magnesia.

In the high-purity caustic-calcined magnesia market (greater than 97% magnesium oxide), producers reported that the plastics market is stable, the pharmaceutical and electrical steel markets are growing, the chemical market is continuing to follow the gross domestic product, and the rubber market has declined because of conditions in the automotive industry. The supply of high-grade magnesia has not changed much in recent years, and there is some overcapacity. Because of the customer-specific properties for each individual application, customers are reluctant to change suppliers once they have been qualified, so new suppliers entering the market are rare. In the low- to medium-grade caustic-calcined magnesia market, Chinese imports are affecting U.S. production. Material from China is beginning to be barged up the Mississippi River to major farming states to capture the agricultural magnesia market, which is considered by producers to show little growth (Harris, 2002). Because of the wide variety of applications for caustic-calcined magnesia, its markets are influenced by varying factors. Growth in one market is likely to be offset by a decline in consumption in another market, so U.S. consumption is expected to remain stable.

Industry sources predict that the market for magnesium hydroxide will continue to grow. Because of the sluggish U.S. economy,

the market for magnesium hydroxide has shown slower growth in the past year than its typical rate of 3% to 4% per year. Both slurry for environmental applications and powder for flame-retardant applications have been in overcapacity, but the slurry overcapacity has been greater. Slurry for water treatment is estimated to grow at rate of 3% to 5% per year through 2006. Demand for magnesium hydroxide for flame-retardant applications has been steady and is expected to remain stable (Van Savage, 2002b).

Magnesium sulfate imports, particularly from Germany, have had an impact on the U.S. market. According to producers, these imports have prevented domestic plants from operating at full production capacity. Consumption growth for magnesium sulfate has been mixed, depending on the market. In the consumer sector—the personal care market and as a secondary nutrient for gardens and lawns—the use of magnesium sulfate in the form of epsom salt has been growing at a rate of about 6% per year. In recent years, the agricultural market, however, has been either flat or declining on an annual basis, mostly because of dry conditions in Florida, where the magnesium in sandy soils is depleted after significant rains. Agricultural use represents about 15% of total magnesium sulfate demand and consists mainly of feed supplements to prevent grass tetany in farm animals (Van Savage, 2002a). Growth or decline in this market most likely will depend on weather conditions.

References Cited

Harris, Paul, 2002, Caustic magnesia—Giving it the water treatment: Industrial Minerals, no. 419, August, p. 25-37.
Industrial Minerals, 2002a, CJC emerges from Britmag demise: Industrial Minerals, no. 419, August, p. 15-16.
Industrial Minerals, 2002b, Optimin j-v acquires Venmag magnesia: Industrial Minerals, no. 412, January, p. 14.
Industrial Minerals, 2002c, UCM signs fused MgO agreement & rationalises in US: Industrial Minerals, no. 412, January, p. 10-11.
Industrial Minerals, 2002d, WestMag delays Pilbara magnesia development: Industrial Minerals, no. 418, July, p. 10.
North American Minerals News, 2002, Quebec govt buys into magnesite-talc money spinner: North American Minerals News, no. 84, May, p. 2.
Pearson, Karine, 2000, Feeling the Chinese burn: Industrial Minerals, no. 392, May, p. 21-33.
Rudi, Fred, 2001, Olivine—A Norwegian forte: Industrial Minerals, no. 410, November, p. 45-49.
Van Savage, Eleanor, 2002a, Imports challenge North American epsom salts market: Chemical Market Reporter, v. 262, no. 6, August 19-26, p. 17.
Van Savage, Eleanor, 2002b, Magnesium hydroxide shows relative balance: Chemical Market Reporter, v. 261, no. 14, April 8, p. 16.

Internet References Cited

American Iron and Steel Institute, [undated], December 2002 selected steel industry data, accessed April 2, 2003, at URL http://www.steel.org/stats/02dec.htm.
Australian Magnesium Corp. Ltd., 2002 (August 30), Preliminary financial report for 2001-02, accessed February 14, 2003, at URL http://www.austmg.com/documents/prelim_fin_report.pdf.
Australian Magnesium Corp. Ltd., 2003 (February 7), Directors' report, accessed February 14, 2003, at URL http://www.austmg.com/documents/Interim_Finreport.pdf.
Ludington Daily News, 2003a (January 7), Dow change means it's here to stay, accessed January 8, 2003, via URL http://www.ludingtondailynews.com.
Ludington Daily News, 2003b (January 7), Future of Harbison-Walker clouded, accessed January 8, 2003, via URL http://www.ludingtondailynews.com.
RHI Refractories Holding Co., 2002 (February 15), RHI Refractories Holding Company moves forward with announced restructuring including reorganization of three businesses, accessed May 6, 2002, at URL http://205.137.187.5/news/pr_restructuringcont.htm.

GENERAL SOURCES OF INFORMATION

U.S. Geological Survey Publications

Historical Statistics for Mineral Commodities in the United States. Open-File Report OF-01-006, version 6.4, 2003.
Magnesian Refractories. Ch. in United States Mineral Resources, Professional Paper 820, 1973.
Magnesium, its Alloys and Compounds. Open-File Report OF-01-341, 2001.
Magnesium Compounds. Ch. in Mineral Commodity Summaries, annual.

Other

Chemical Market Reporter, weekly.
Industrial Minerals, monthly.
Magnesite and Magnesia. Ch. in Industrial Minerals and Rocks (6th ed.), Society for Mining, Metallurgy, and Exploration, Inc., 1994.
Magnesium. Ch. in Mineral Facts and Problems, U.S. Bureau of Mines Bulletin 675, 1985.
Magnesium and Magnesite in the CIS in 1996 (2d ed.). Roskill Information Services Ltd.
Magnesium Compounds and Chemicals (9th ed.). Roskill Information Services Ltd., 2001.
Olivine (2d ed.). Roskill Information Services Ltd., 1990.

TABLE 1
SALIENT MAGNESIUM COMPOUND STATISTICS[1]

(Thousand metric tons and thousand dollars)

	1998	1999	2000	2001	2002
United States:					
Caustic-calcined and specified magnesias:[2]					
Shipped by producers:[3]					
Quantity	177	179	172	136	127
Value	$76,700	$77,000	$46,000	$43,300	$38,100
Exports[4]	5	3	12	4	6
Imports for consumption[4]	127	123	136	130	148
Refractory magnesia:					
Shipped by producers:[3]					
Quantity	215	216	196	213	123
Value	$75,000	$75,300	$68,100	$71,300	$37,800
Exports	63	67	60	63	73
Imports for consumption	427	392	501	363	394
World, production of magnesite	11,400	9,830 r	12,700 r	11,200 r	11,200 e

eEstimated. rRevised.

[1]Data are rounded to no more than three significant digits.

[2]Excludes caustic-calcined magnesia used in the production of refractory magnesia.

[3]Includes magnesia used by producers.

[4]Caustic-calcined magnesia only.

TABLE 2
U.S. MAGNESIUM COMPOUND PRODUCERS, BY RAW MATERIAL SOURCE, LOCATION, AND PRODUCTION CAPACITY, IN 2002

Raw material source and producing company	Location	Capacity (metric tons of MgO equivalent)[1]	Products
Brucite, Applied Chemical Magnesias Corp.	Van Horn, TX, and Bullhead City, AZ	25,000	Magnesium hydroxide.
Magnesite, Premier Chemicals LLC	Gabbs, NV	140,000	Caustic-calcined and dead-burned magnesia.
Lake brines:			
Great Salt Lake Minerals Corp.	Ogden, UT	106,000	Magnesium chloride and magnesium chloride brines.
Reilly Industries Inc.	Wendover, UT	45,000	Magnesium chloride brines.
Well brines:			
The Dow Chemical Co.[2]	Ludington, MI	214,000	Magnesium hydroxide.
Martin Marietta Magnesia Specialties LLC[3]	Manistee, MI	297,000	Caustic-calcined and dead-burned magnesia.
Rohm and Haas Co.	do.	25,000	Magnesium carbonate, magnesium hydroxide, and caustic-calcined magnesia.
Seawater:			
Premier Chemicals LLC	Port St. Joe, FL	75,000	Caustic-calcined magnesia and magnesium hydroxide.
SPI Pharma Inc.	Lewes, DE	5,000	Magnesium hydroxide.
Western Salt Co.	Chula Vista, CA	3,000	Magnesium chloride brines.
Total		935,000	

[1]Data are rounded to no more than three significant digits; may not add to total shown.

[2]Most of Dow's production was shipped to ANH Refractories Co. in Ludington, MI, where it was converted to dead-burned magnesia at a 200,000-metric-ton-per-year-capacity plant.

[3]In addition to its Michigan plant, Martin Marietta owned a 15,000-metric-ton-per-year-capacity magnesium hydroxide plant in Lenoir City, TN, which used imported magnesite as a raw material.

TABLE 3

U.S. MAGNESIUM COMPOUNDS SHIPPED AND USED[1]

	2001		2002	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Caustic-calcined and specified (USP and technical) magnesias[2]	136,000	$43,300	127,000	$38,100
Magnesium hydroxide [100% $Mg(OH)_2$][1]	268,000	100,000	218,000	86,900
Magnesium sulfate, anhydrous and hydrous	38,100	12,000	38,000	12,400
Precipitated magnesium carbonate[2]	1,750	4,170	1,710	4,130
Refractory magnesia	213,000	71,300	123,000	37,800

[1]Data are rounded to no more than three significant digits.

[2]Excludes material produced as an intermediate step in the manufacture of other magnesium compounds.

TABLE 4
YEAREND MAGNESIUM COMPOUND PRICES

Material		2001	2002
Magnesia, dead-burned	per short ton	$388	$388
Magnesia, synthetic, technical, 98% MgO	do.	488	488
Magnesium chloride, hydrous, 99%, flake	do.	290	290
Magnesium chloride, anhydrous, 92%, flake or pebble	per pound	$0.1275-0.15	0.145
Magnesium hydroxide, powder, technical	do.	0.45	0.45
Magnesium hydroxide slurry, technical, 100% $Mg(OH)_2$	do.	210	210
Magnesium sulfate, technical (epsom salts)	do.	0.18-0.195	$0.175-0.21
Olivine, aggregate, free on board plant or mine	per metric ton	50-78	50-78
Olivine, foundry grade, free on board plant or mine	do.	60-110	62-109

Sources: Chemical Market Reporter and Industrial Minerals.

TABLE 5

U.S. EXPORTS OF CRUDE AND PROCESSED MAGNESITE, BY COUNTRY[1]

Material and country	2001 Quantity (metric tons)	2001 Value (thousands)	2002 Quantity (metric tons)	2002 Value (thousands)
Caustic-calcined magnesia:				
Brazil	367	$527	390	$419
France	1,570	1,000	2,850	1,660
Germany	332	217	327	193
Italy	99	59	763	406
Japan	536	569	--	--
Netherlands	476	321	856	492
Other	374 r	259 r	347	223
Total	3,750	2,960	5,540	3,390
Dead-burned and fused magnesia:				
Austria	7,270	1,780	6,000	1,460
Canada	40,600	12,300	54,400	15,800
Chile	1,500	504	2,060	640
Germany	5,310	1,850	4,410	1,200
Japan	2,270	700	57	42
Korea, Republic of	683	582	1,040	513
Mexico	936	448	1,240	648
Netherlands	717	352	749	470
Vietnam	1,120	322	--	--
Other	2,780 r	2,370 r	2,730	2,190
Total	63,100	21,200	72,700	22,900
Other magnesia:				
Canada	10,500	3,460	6,880	2,510
Colombia	1,550	585	4,240	972
Germany	1,470	11,400	304	518
Hong Kong	1,100	1,400	866	1,050
Indonesia	1,730	1,090	1,180	659
Japan	1,870	1,610	5,750	4,980
Mexico	11,600	6,930	7,100	5,240
Taiwan	2,150	1,280	1,020	640
Venezuela	980	363	--	--
Other	3,730 r	15,900 r	4,520	5,480
Total	36,600	44,100	31,900	22,000
Crude magnesite:				
Argentina	1,040	111	762	81
Brazil	2,400	256	--	--
Canada	2,950	406	2,260	335
France	1,470	157	2,820	302
Korea, Republic of	1,100	151	--	--
Spain	2,870	332	--	--
United Kingdom	1,070	121	2,250	240
Venezuela	2,520	347	8,760	1,080
Other	3,380 r	416 r	2,290	264
Total	18,800	2,300	19,100	2,310

rRevised. -- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

Source: U.S. Census Bureau.

TABLE 6

U.S. EXPORTS OF MAGNESIUM COMPOUNDS[1]

Material	2001 Quantity (metric tons)	2001 Value (thousands)	2002 Quantity (metric tons)	2002 Value (thousands)	Principal destinations, 2002
Magnesium chloride, anhydrous and other	3,630	$5,080	4,580	$2,340	Canada, 90%.
Magnesium hydroxide and peroxide	20,800	9,630	14,500	11,000	Canada, 61%; Germany, 14%.
Magnesium sulfate, natural kieserite and epsom salts	406	223	3,350	449	Canada, 81%; Panama, 16%.
Magnesium sulfate, other	6,360	3,860	7,450	3,610	Canada, 82%.

[1]Data are rounded to no more than three significant digits.

Source: U.S. Census Bureau.

TABLE 7

U.S. IMPORTS FOR CONSUMPTION OF CRUDE AND PROCESSED MAGNESITE, BY COUNTRY[1]

Material and country	2001 Quantity (metric tons)	2001 Value (thousands)	2002 Quantity (metric tons)	2002 Value (thousands)
Caustic-calcined magnesia:				
Canada	42,500	$8,000	49,200	$8,850
China	77,400	9,230	88,700	9,920
Greece	5,200	1,340	4,240	1,090
Other	4,780	4,830	5,400	4,530
Total	130,000	23,400	148,000	24,400
Dead-burned and fused magnesia:				
Australia	55,600	11,000	55,700	11,400
Austria	14,000	5,520	13,100	5,380
Brazil	9,500	994	--	--
China	245,000	36,400	286,000	40,500
Greece	--	--	4,630	1,790
Hong Kong	11,900	1,480	17,800	2,060
Israel	11,700	7,280	6,830	5,230
Other	15,400	4,570	9,880	3,700
Total	363,000	67,200	394,000	70,100
Other magnesia:				
Canada	3,160	775	1,390	369
China	453	117	3,320	1,320
Israel	2,410	5,280	1,910	4,830
Japan	1,670	3,220	1,810	3,280
Mexico	6,660	2,420	5,830	1,870
Slovakia	1,640	738	2,770	1,180
Other	1,170 r	908 r	570	757
Total	17,200	13,400	17,600	13,600
Crude magnesite:				
China	4,650	438	5,600	428
Israel	6	10	709	150
Japan	2,440	545	3,780	813
United Kingdom	3,210	690	76	57
Other	1,180	262	1,420	289
Total	11,500	1,950	11,600	1,740

rRevised. -- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

Source: U.S. Census Bureau.

TABLE 8

U.S. IMPORTS FOR CONSUMPTION OF MAGNESIUM COMPOUNDS[1]

	2001		2002		
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Principal sources, 2002
Magnesium chloride, anhydrous and other	62,000	$8,840	20,100	$4,930	Israel, 90%.
Magnesium hydroxide and peroxide	6,930	10,500	3,930	6,000	Netherlands, 30%; Austria, 20%.
Magnesium sulfate, natural epsom salts	77	20	65	29	Germany, 56%; China, 28%.
Magnesium sulfate, natural kieserite	22,500	640	13,300	815	Germany, 100%.
Magnesium sulfate, other	36,900	8,430	30,900	5,830	Germany, 53%; Canada, 40%.

[1]Data are rounded to no more than three significant digits.

Source: U.S. Census Bureau.

TABLE 9
WORLD MAGNESIUM COMPOUNDS ANNUAL PRODUCTION CAPACITY,
DECEMBER 31, 2002[1, 2]

(Thousand metric tons of MgO equivalent)

	Raw material				
	Magnesite		Seawater or brines		
Country	Caustic-calcined	Dead-burned	Caustic-calcined	Dead-burned	Total
North America:					
Canada	150	--	--	--	150
Mexico	--	--	15	95	110
United States	NA	NA	NA	NA	935 [3]
Total	150	NA	15	95	1,200
South America, Brazil	80	291	--	--	371
Europe:					
Austria	25	250	--	--	275
France	--	--	30	--	30
Greece	120	100	--	--	220
Ireland	--	--	--	90	90
Italy	25	--	5	70	100
Netherlands	--	--	8	150	158
Poland	--	10	--	--	10
Russia	100	2,670	--	--	2,770
Serbia and Montenegro	40	200	--	--	240
Slovakia	--	330	--	--	330
Spain	150	100	--	--	250
Turkey	20	309	--	--	329
Ukraine	--	120	20	80	220
United Kingdom	--	--	70	80	150
Total	480	4,090	133	470	5,170
Africa:					
South Africa	12	--	--	--	12
Zimbabwe	20	--	--	--	20
Total	32	--	--	--	32
Asia:					
China	200	2,480	--	10	2,690
India	25	261	--	--	286
Iran	--	30	--	--	30
Israel	--	--	10	60	70
Japan	--	--	50	250	300
Korea, North	--	500	--	--	500
Korea, Republic of	--	--	--	50	50
Total	225	3,270	60	370	3,920
Oceania, Australia	48	150	--	--	198
Grand total	1,020	7,800	208	935	10,900

NA Not available. -- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown. Revised August 5, 2003.

[2]Includes capacity at operating plants, as well as at plants on standby basis.

[3]Includes capacity for production of magnesium chloride, magnesium chloride brines, magnesium carbonate, magnesium hydroxide, and caustic-calcined and dead-burned magnesias.

TABLE 10

MAGNESITE: WORLD PRODUCTION, BY COUNTRY[1, 2]

(Metric tons)

Country	1998	1999	2000	2001	2002[e]
Australia	360,115	280,505	349,783	605,314 [r]	484,498 [3]
Austria, crude	723,000	749,000	726,000	700,000 [e]	700,000
Brazil, beneficiated[4]	308,300	259,834	279,876	265,749 [r]	270,000
Canada[e, 5]	180,000	180,000	180,000	180,000	180,000 [p]
China[e]	2,400,000	2,450,000	4,070,000 [r]	3,580,000 [r]	3,700,000
Colombia[e]	10,500	10,500	10,500	10,500	10,500
Greece, crude[e]	650,000	495,144 [3]	500,000	500,000	500,000
India	355,033	360,080	365,080	370,000 [e]	380,000
Iran[6]	109,597	141,081	141,000 [e]	143,000 [r, e]	140,000
Korea, North[e]	1,500,000	1,000,000	1,000,000	1,000,000	1,000,000
Mexico	274	308	335	350	350
Pakistan	3,157	2,175	4,192	4,200 [e]	4,000
Philippines[e]	-- [r]	-- [r]	-- [r]	-- [r]	--
Poland, concentrate	33,700 [r]	38,800 [r]	26,100 [r]	22,200 [r]	25,000
Russia[e]	851,845 [3]	900,000	1,000,000	1,000,000	1,000,000
Serbia and Montenegro, crude	81,000	31,000	41,000 [r]	36,000	35,000
Slovakia, concentrate	877,840	918,000	1,000,000 [r]	447,000 [r]	500,000
South Africa	74,300	73,900	63,000 [r]	33,900 [r]	40,000
Spain, calcined	201,000	211,000	266,000	260,000 [e]	250,000
Turkey, run-of-mine	2,703,343	1,724,744	2,672,089	2,000,000 [e]	2,000,000
United States	W	W	W	W	W [3]
Zimbabwe	4,321	5,356	4,029 [r]	2,439 [r]	2,366 [3]
Total	11,400,000	9,830,000 [r]	12,700,000 [r]	11,200,000 [r]	11,200,000

[e]Estimated. [p]Preliminary. [r]Revised. W Witheld to avoid disclosing company proprietary data; not included in "Total." -- Zero.

[1]World totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]Figures represent crude salable magnesite. In addition to the countries listed, Bulgaria produced magnesite, but output is not reported quantitatively; and available information is inadequate for formulation of reliable estimates of output levels. Table includes data available through May 20, 2003.

[3]Reported figure.

[4]Series reflect output of marketable concentrates. Production of crude ore was as follows, in metric tons: 1998--1,109,351; 1999--868,604; 2000--1,006,654; 2001--1,079,207 (revised); and 2002--1,100,000 (estimated).

[5]Magnesitic dolomite and brucite. Figures are estimated on the basis of reported tonnage dollar value.

[6]Year beginning March 21 of that stated.

FIGURE 1
U.S. STEEL PRODUCTION AND DEAD-BURNED MAGNESIA CONSUMPTION

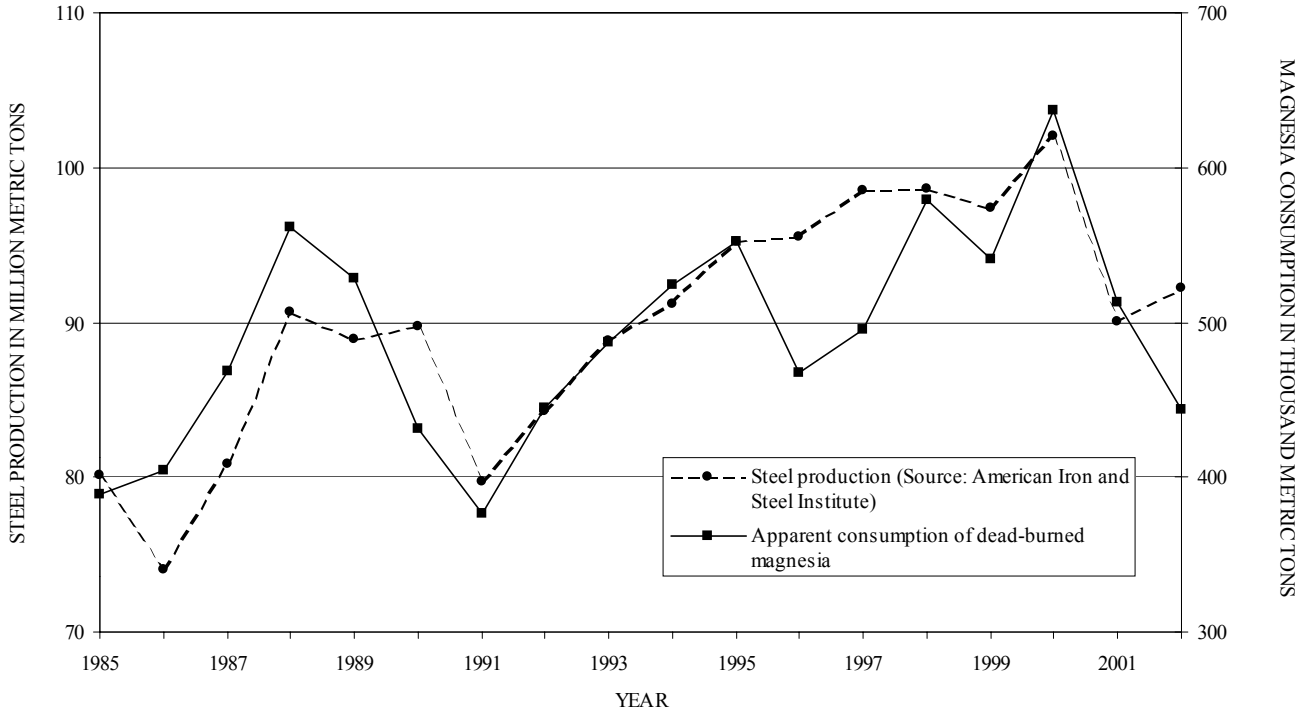

FIGURE 2
U.S. DEAD-BURNED MAGNESIA STATISTICS